CLAIMS

1. A glassy-film-forming coating agent comprising compounds represented by the following general formulae (1), (2) and (3):

$$R^1_pSi(OR^2)_{4-p} \quad (1)$$

$$R^2(OSi(OR^2)_2)_qOR^2 \quad (2)$$

$$M(OR^3)_r \quad (3)$$

wherein

R^1 is a polymerizable organic group,

R^2 is an alkyl group having not more than 4 carbon atoms,

R^3 is an alkyl group having not more than 6 carbon atoms,

p is an integer of 1 to 3,

q is an integer of 1 to 10,

M is a trivalent or tetravalent metal ion, and

r is an integer of 3 or 4 corresponding to the valence of M,

provided that, when one of the compounds contains two or more R^1s, R^2s or R^3s, they may be the same or different.

2. The coating agent according to claim 1, comprising the compounds in the following proportions:

compound (1): 40 to 80 mol%,

compound (2): 10 to 30 mol%, and

compound (3): 10 to 50 mol%.

3. The coating agent according to claim 1 or 2, further comprising a polymerization initiator.

4. The coating agent according to any of claims 1 to 3, further comprising an organic pigment, a dispersant and a solvent.

5. The coating agent according to any of claims 1 to 4, wherein R^1 is an organic group having unsaturated double bond.

6. The coating agent according to any of claims 1 to 5, wherein R^1 is vinyl or γ-methacryloxypropyl group, R^2 is methyl or ethyl group,

R^3 is ethyl, methyl, isopropyl or butyl group, and M is Ti, Zr or Al.

7. A glassy-film-coating method comprising:

applying, to a substrate, a coating agent which comprises compounds represented by the following general formulae (1), (2) and (3):

$R^1_pSi(OR^2)_{4-p}$ (1)

$R^2(OSi(OR^2)_2)_qOR^2$ (2)

$M(OR^3)_r$ (3)

wherein

R^1 is a polymerizable organic group,

R^2 is an alkyl group having not more than 4 carbon atoms,

R^3 is an alkyl group having not more than 6 carbon atoms,

p is an integer of 1 to 3,

q is an integer of 1 to 10,

M is a trivalent or tetravalent metal ion, and

r is an integer of 3 or 4 corresponding to the valence of M,

provided that, when one of the compounds contains two or more R^1s, R^2s or R^3s, they may be the same or different, and

subjecting the coating agent applied to the substrate to irradiation and/or heat treatment.

8. The method according to claim 7, wherein the substrate is made of glass.

9. The method according to claim 7, wherein the substrate is made from a plastic.

10. The method according to any of claims 7 to 9, wherein the heating temperature is from 60 to 300°C.

11. The method according to any of claims 7 to 10, further comprising, between the step of applying the coating agent to the substrate and the step of subjecting the coating agent applied to the substrate to irradiation and/or heat treatment, the step of removing a solvent contained in the coating layer in order to cause phase separation inside the coating layer, thereby making the appearance of the coating layer frosty.

12. The method according to claim 11, wherein, after applying the coating agent to the substrate, the solvent is removed by blowing air on the coating layer formed.

13. A coated bottle produced by applying, to a bottle, substrate, a coating agent comprising compounds represented by the following general formulae (1), (2) and (3):

$R^1_pSi(OR^2)_{4-p}$ (1)

$R^2(OSi(OR^2)_2)_qOR^2$ (2)

$M(OR^3)_r$ (3)

wherein

R^1 is a polymerizable organic group,

R^2 is an alkyl group having not more than 4 carbon atoms,

R^3 is an alkyl group having not more than 6 carbon atoms,

p is an integer of 1 to 3,

q is an integer of 1 to 10,

M is a trivalent or tetravalent metal ion, and

r is an integer of 3 or 4 corresponding to the valence of M,

provided that, when one of the compounds contains two or more R^1s, R^2s or R^3s, they may be the same or different, and

subjecting the coating agent applied to the bottle to irradiation and/or heat treatment.

14. The coated bottle according to claim 13, wherein the substrate is a glass bottle.

15. The coated bottle according to claim 13, wherein the substrate is a plastic bottle.

16. The coated bottle according to any of claims 13 to 15, wherein, between the application of the coating agent to the substrate and the irradiation and/or heat treatment, a solvent contained in the coating layer is removed in order to cause phase separation inside the coating layer, thereby making the appearance of the coating layer frosty.

17. The coated bottle according to claim 16, wherein, after applying the coating agent to the substrate, the solvent is removed by blowing air on the coating layer formed.

18. A glassy-film-coating system comprising the following units:

(a) a coater for applying, to a substrate, a glassy-film-forming coating agent which comprises compounds represented by the following general formulae (1), (2) and (3):

$R^1_pSi(OR^2)_{4-p}$ (1)

$R^2(OSi(OR^2)_2)_qOR^2$ (2)

$M(OR^3)_r$ (3)

wherein

R^1 is a polymerizable organic group,

R^2 is an alkyl group having not more than 4 carbon atoms,
R^3 is an alkyl group having not more than 6 carbon atoms,
p is an integer of 1 to 3,
q is an integer of 1 to 10,
M is a trivalent or tetravalent metal ion, and
r is an integer of 3 or 4 corresponding to the valence of M,

provided that, when one of the compounds contains two or more R^1s, R^2s or R^3s, they may be the same or different, and

(b) a coating-hardening unit for irradiating and/or heating the coating agent applied to the substrate.

19. The glassy-film-coating system according to claim 18, wherein the coating agent is applied to the substrate by the coater by means of dip coating.

20. The glassy-film-coating system according to claim 18 or 19, wherein the coating-hardening unit is composed of an irradiator and a heater.

21. The glassy-film-coating system according to any of claims 18 to 20, wherein the system comprises a conveyer, and the substrate attached to this conveyer is successively subjected to the following steps of:

(i) applying the coating agent to the substrate by the coater by means of dip coating;

(ii) irradiating the coating agent applied to the substrate with ultraviolet light by using the irradiator; and

(ii) heating the irradiated coating agent to 60 to 300°C by the heater.